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Morphology of adult and immature stages of *Amorophaga japonica* Robinson, 1986 (Lepidoptera, Tineidae)

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Abstract Morphological characters of adult and immature stages of *Amorophaga japonica* Robinson, 1986 are described on the basis of material collected from fruit bodies of the Polyporaceae fungus, *Cryptoporus volvatus* (Peck) Shear., on decayed wood of *Pinus densiflora* Sieb. et Zucc.

Key words *Cryptoporus volvatus*, Japan, larva, morphology, pupa, Scardiinae.

Introduction

The genus *Amorophaga* was established based on *Amorophaga hyrcanica* Zagulajev, 1968 (Zagulajev, 1968). The genus belongs to the subfamily Scardiinae of the Tineidae, and consists worldwide of four species, *A. cryptophori* Clarke, 1940, *A. hyrcanica* Zagulajev, 1968, *A. japonica* Robinson, 1986, and *A. rosemariae* Robinson, 1986, (Zagulajev, 1973; Robinson, 1986).

Only one species, *A. japonica*, has been recorded in Japan: it was found to feed on fruit bodies of the wood-decaying bracket fungus *Cryptoporus volvatus* (Polyporaceae: Basidiomycota) (Kadowaki and Yamazoe, 2011; Sakai, 2013). Robinson (1986) described this species as a new species based on male material. Subsequently, Yang and Li (2013) recorded the species from China and described the female genitalia. However, the immature stages of this species remained undescribed. In the present study, the adult morphology of this species is redescribed in detail, with description of the immature stages.

Materials and methods

Materials of the adults of. *Amorophaga japonica* from several localities in Japan were examined and deposited in the collection of Osaka Prefecture University (OPU), Kyoto University (KYU) and Kyushu University (KU). For preparation of the male and female genitalia, the abdomen was removed and boiled for 5-6 minutes in 10% aqueous KOH and stained with acetocarmine for 3-4 minutes. For observation of the wing venation, the forewing and hindwing were cleaned to remove the scales using a raccoon-fur brush in 70% EtOH solution, and stained with acetocarmine for 6 hours. For preparation of observations on the morphology of the immature stages, the larvae were boiled for 4-5 minutes in 10% aqueous KOH and stained with acetocarmine for 10 minutes. Terminology and nomenclature of morphological characters of the immature stages follows Moriuti (1976), Stehr (1987) and Komai *et al.* (2011).

For examination of immature characters of the species, larvae were collected from the fruit bodies of *Cryptoporus volvatus* on decayed woods of *Pinus densiflora* Sieb. et Zucc. in No-touge, Miyako-machi, Fukuoka Pref., Japan on 23. viii. 2013. Collected larvae were reared using fruit body of *C. volvatus* as food in plastic cups containing wet cotton at 20±5 ℃ under a photoperiod of 13~16-h light: 8~12-h dark in the

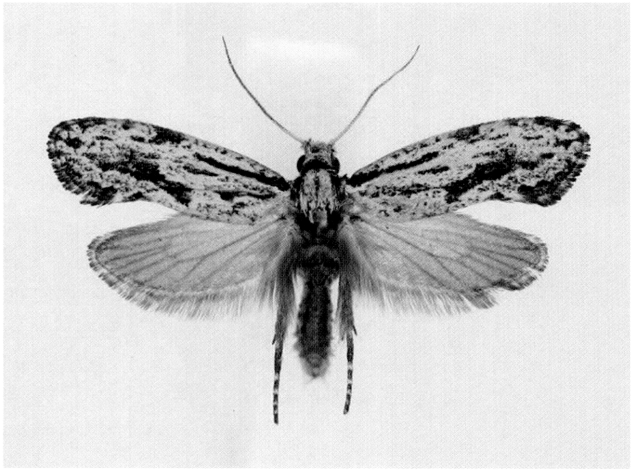

Fig. 1. Adult of *Amorophaga japonica* Robinson, 1986, ♂.

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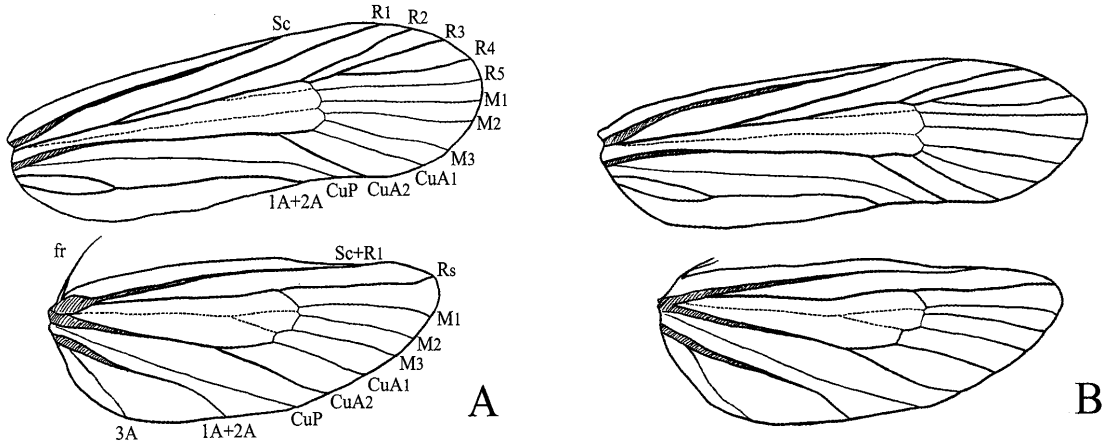

Fig. 2. Wing venations of *A. japonica*. A: Male. B: Female.

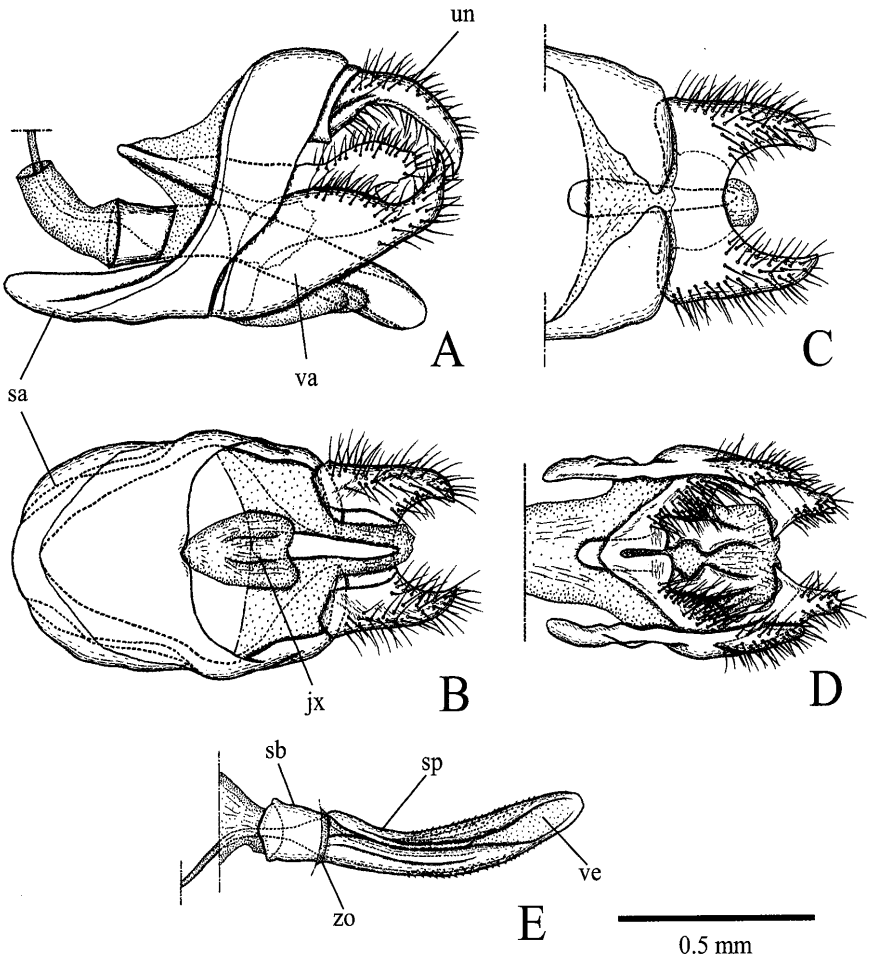

Fig. 3. Male genitalia of *A. japonica*. A: Whole genitalia, lateral view. B: *Ditto*, ventral view. C: Uncus and tegumen, dorsal view. D: Valva, juxta and anellus dorsal view. E: Phallus, lateral view. (jx: juxta, sa: saccus, sb: subzonal sheath, sp: suprazonal sheath, un: uncus, va: valva, ve: vesica, zo: zone)

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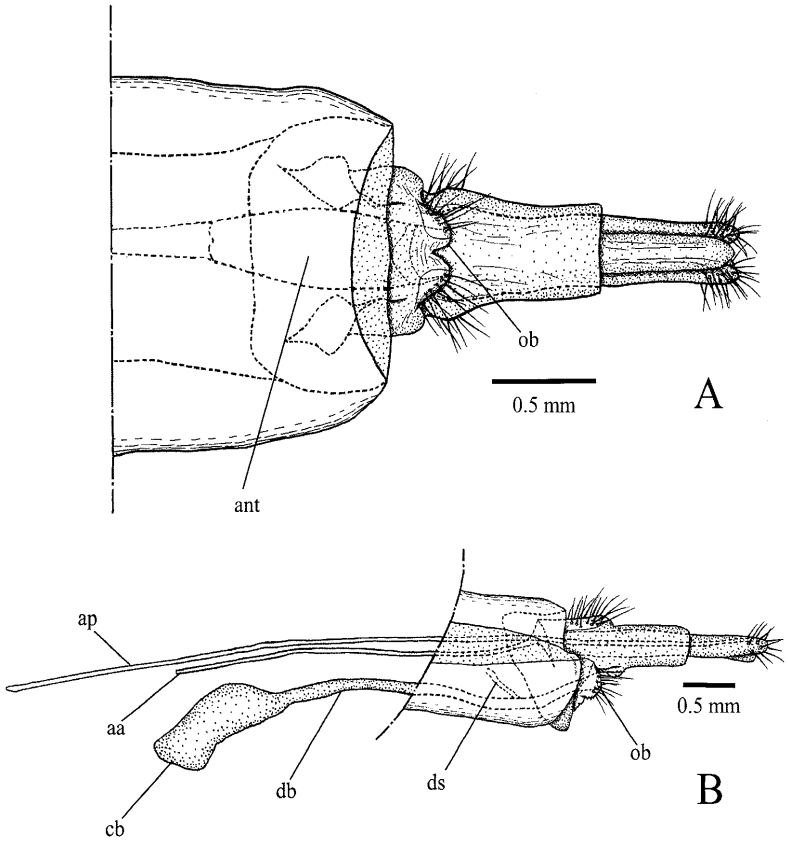

Fig. 4. Female genitalia of *A. japonica*. A: Female genitalia except bursa copulatrix, ventral view. B: *Ditto*, lateral view. (aa: apophysis anterioris, ap: apophysis posterioris, ant: antrum, cb: corpus bursae, db: ductus bursae, ds: ductus seminalis, ob: ostium bursae)

laboratory during from 23. viii. to 7. ix. 2013. The external structures of pupal specimens of the species were examined using a scanning electron microscope (SEM). The SEM specimens were prepared using the standard fixation techniques (2.5% glutaraldehyde), were dried by a critical point drier, and were sputter-coated with a 60:40 mixture of gold-palladium for examination. The following parts were examined using SEM (HITACHI S-3000N): thoracic segments, spines on abdominal segments, and terminal segments.

Description

Amorophaga japonica Robinson, 1986

[Japanese name: Sujimon-ohirozukoga]

Amorophaga japonica Robinson, 1986: 114, figs 59, 112. [Type locality: Japan], Sakai, 2013: 119, pl. 3-11-2, 3, figs Tin2.-1a, 1b. Yang & Li, 2013; 668-671, figs 1-7.

Diagnosis. The ground color of the forewing is grayish white with dark brown longitudinal streaks. In the male genitalia, the uncal lobes are elongate and taper; the gnathos is absent; the dorsal lobe of the valva is shorter than the ventral lobe. In the female, the eighth abdominal sternum is bilobed subventrally. This species is externally similar to *A. hyrcanica*, but they are different as follows: the dark brown longitudinal streaks on the forewing of this species are larger than in *A. hyrcanica*, and the uncus is shorter and the dorsal process of the valva is shorter than in *A. hyrcanica*.

Description. Length of forewing 8.5-9.7 mm; forewing expanse 18.0-21.5 mm. Head: vertex and face clothed with grayish white hairs. Antenna filiform ciliated ventrally, about 1/2 length of forewing; scape brownish white; pecten consisting of more than 20 bristles; each flagellomere covered with a row of grayish white scales dorsally. Maxillary palpus covered with grayish white

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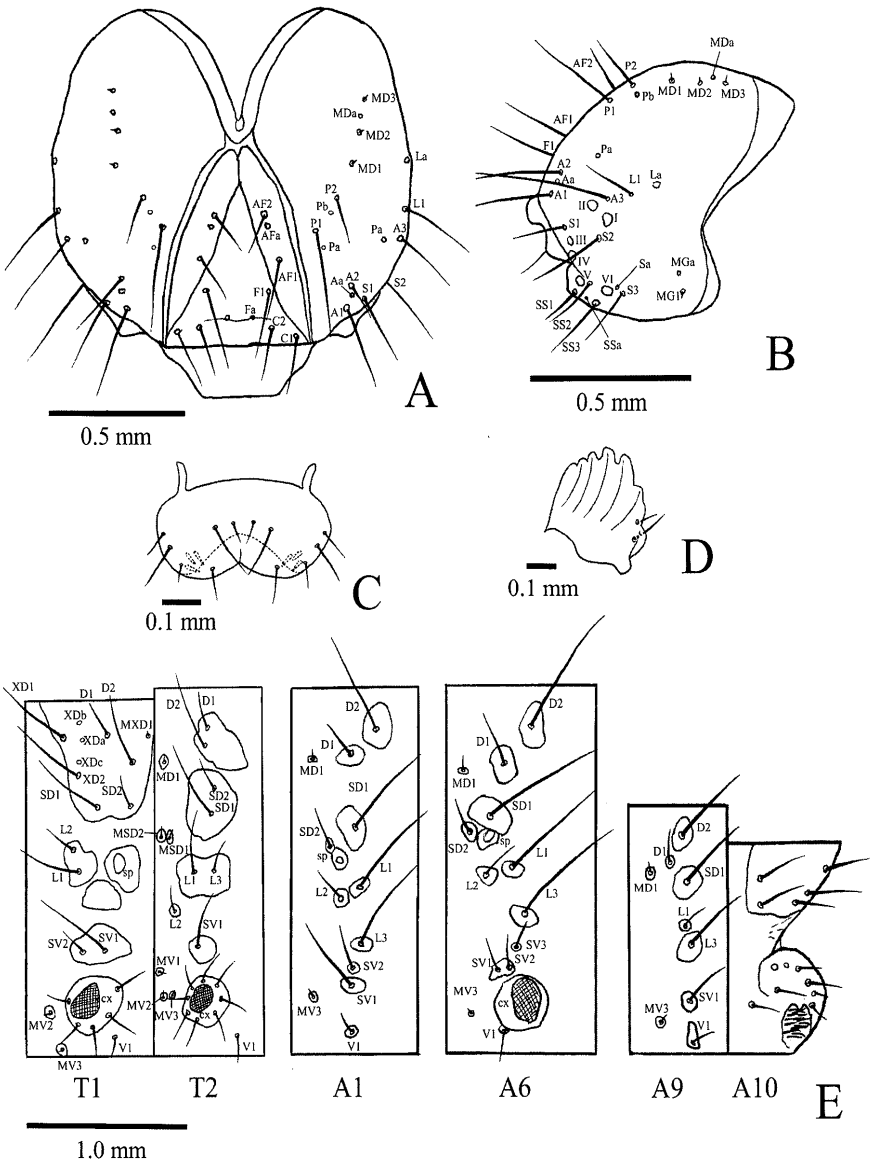

Fig. 5. Mature larva of *A. japonica*. A: Head capsule, frontal view. B: *Ditto*, lateral view. C: Labrum, frontal view. D: Mandible, inner view. E: Body setal map.

scales. Labial palpus covered with grayish white scales; second segment with 30-40 lateral bristles. Thorax: mesonotum grayish white, and tegula dark brown anteriorly and gray posteriorly; metanotum clothed with grayish white scales on scutellum and posterior part of scutum. Legs extensively covered with dark brown scales; hind tibia bearing dense long hairs dorsally and ventrally. Abdomen covered with glassy gray scales. Eighth abdominal segment without coremata.

Wing markings (Fig. 1). Forewing upperside grayish white in ground color, speckled with dark brown to form irregular longitudinal streaks, costa and termen with 15-17 markings. Fringe chequered with gray and dark brown scales alternately. Hindwing upperside glassy pale gray; basal 3/5 of costa covered with yellowish white scales. Fringe yellowish white.

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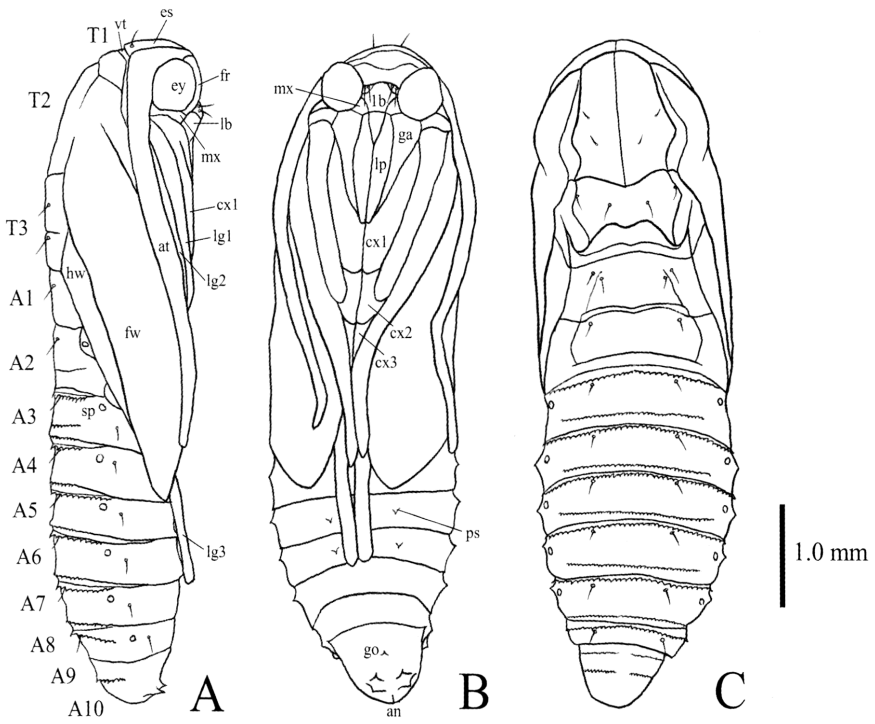

Fig. 6. Male pupa of *A. japonica*. A: Lateral view. B: Ventral view. C: Dorsal view. (at: antenna, an: anus, cx: coxa, e: epicranial suture, fr: frons, fw: forewing, ga: galea, go: genital opening, lb: labrum, lp: labial pulpus, lg: leg, mx: maxillary palpus, ps: proleg scars, sp: spiracle, vt: vertex)

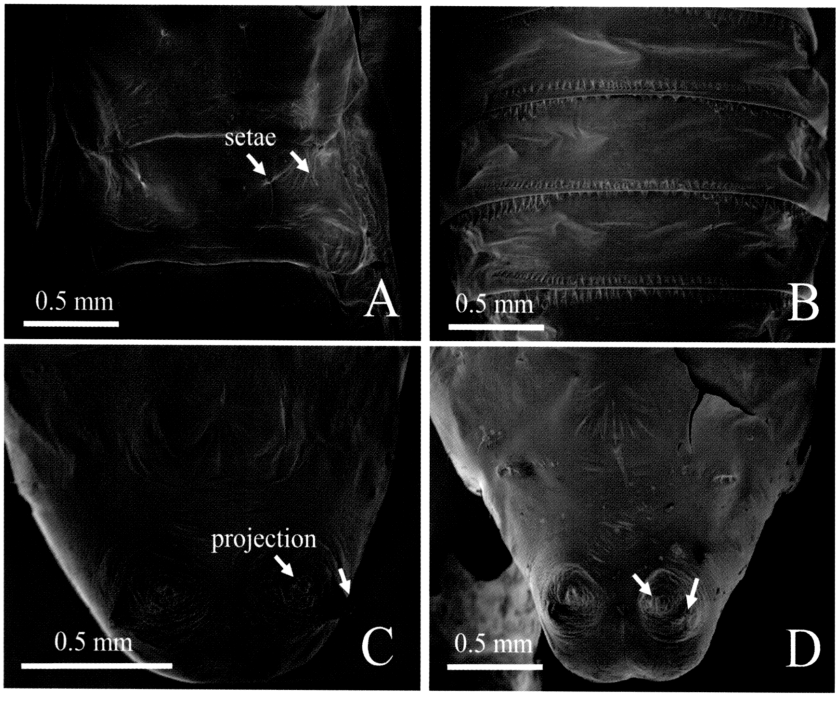

Fig. 7. Scanning electron micrograph images of pupa of *A. japonica*. A: Meso- and metathoraces, dorsal view. B: Spines on abdominal segments 7-9, dorsal view. C: Terminal segments, ventral view, ♂. D: *Ditto*, ♀.

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Fig. 8. Larva, pupa and host fungus. A: *Pinus densiflora* tree. B: *Cryptoporus volvatus* on trunk of *Pinus densiflora*. C: Larva boring in fruit body. D: Pupa inner cocoon in interstice of fruit body. E: Slough in fruit body. F: Adult on fungus.

Wing venation (Fig. 2). Forewing with veins almost free; R1 arising from basal 1/3 of discoidal cell; R3 and R4 stalked; R5 ending at apex; chorda absent; apex of discoidal cell rounded. Hindwing with all free veins; M stem branched in discoidal cell.

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Male genitalia (Fig. 3). Tegumen and vinculum fused into a ring; tegumen membranous dorsally; tegumen and uncus separated; uncus divergent, elongate and curved ventrally with setae, apex of uncus acute; gnathos absent; subscaphium a linear plate; width of vinculum 1/2 length of uncus; saccus rounded, saccus as long as uncus. Valva distally emarginate; dorsal process apically round with setae; ventral lobe tapered with an acute process with setae posteriorly; thorn-like inward process; valval apodeme developed and 1/3 length of valva; inner surface fused anteriorly and concave mesally with setae, membranous longitudinally. Juxta slightly sclerotized and bilobed. Phallus stout and slightly arched; suprazonal sheath about 1/7 phallus; subzonal sheath about 6/7 phallus with specular carinae, about 8 times as long as broad in middle; vesica without cornuti.

Female genitalia (Fig. 4). Eighth abdominal tergum developed with setae; eighth abdominal sternum slightly bilobed subventrally with setae, almost membranous except posterior and lateral edges. Antrum divided into a posterior ring and tapered anteriorly. Ductus bursae as long as apophysis anterioris. Corpus bursae about 1/3 ductus bursae, without signum.

Adults examined: [Honshu] (Ibaraki Pref.) 1♂1♀, Kannnondai, tsukuba-shi, 18. ix. 2000, M. Sakai leg. (Tokyo Pref.) 4♂1♀, Mt. Takao, Hachioji-shi, 24. v. 1998, emerged 30. v. 1998 (lavae collected, 24. v. 1998), N. Tsukasa leg. (Kanagawa Pref.) 1♂, Mt. Kobo, Hadano-shi, 23. v. 1998, M. Sakai leg. (Ishikawa Pref.) 1♂, Kiba, Komatsu-shi, 20. v. 1983, A. Tomisawa leg. (Fukui Pref.) 2♀, Ikeizumi, Takeo-shi, 28. v. 1963, K. Fukuda leg. (Aichi Pref.) 1♀, Mizukake, Toyoake-shi, 18. iv. 2000, Y. Yoshizuru leg. (Mie Pref.) 1♀, Hijiki, Ueno-shi, 27. vi. 1997, T. Mano leg. (Shiga Pref.) 1♂, Aikyo-no-mori, Higashiomi-shi, 20. vi. 1998, T. Saito leg. (Kyoto Pref.) 2♀, Amabiki-toge, Sonobe-cho, 17. vi. 1998, emerged in early-July. 1998, N. Tsukasa leg (larvae collected, 17. vi. 1998).; 3♂3♀, Sagakiyotaki, Kyoto-shi, 13. vi. 2004, K. Kadowaki leg. (Wakayama Pref.) 1♂, Hirai, Kozagawa-machi, 20. v. 1998, T. Saito leg. (Tottori Pref.) 1♂, Hoki-daisen-machi, 9. vii. 1964, S. Moriuti leg. [Shikoku] (Kagawa Pref.) 2♂2♀, Shodo-shima, 25. v. 2005, K. Kadowaki leg. [Kyushu] (Fukuoka Pref.) 1♂, Ushikubi, Onojo-shi, 17. v. 1997, K. Yamazoe leg.

Mature larva (Fig. 5). Max length 11mm. Head capsule dark brown, with mottled appearance. Head brown, with six stemmata. Body light brownish white; pinacula large, dark brown, conspicuous; all setae dark brown; prothoracic shield brown; thoracic legs brown with light brown claw; peritreme of spiracles brown; anal shield almost concolorous with body; crochets on ventral proleg in a uniordinal circle, 20-25; crochets on anal proleg in a semicircle, 15-16.

Head (Figs 5A-D). Head much broader than long, frontoclypeal area about 4/5 of distance to vertical triangle, the part being appreciably longer than wide; stemmata III and IV close. Labrum as shown in Fig. 5C. Mandible as shown in Fig. 5D.

Chaetotaxy (Fig. 5). Head: cranial setae as shown in Figs 5A-B; MDa between MD2 and MD3; Pa above A3; Pb nearer to P2 than P1; Aa nearer to A2 than A1; A2 above A1; SSa between SS1 and SS3; AFa nearer to AF2 than AF1; La behind L1. Body: setae as shown in Fig. 5E. Prothorax: thoracic shield bearing D1, D2, XD1, XD2, SD1, SD2, XDa, XDb, XDc and MXD1; L1 and L2 on a common pinaculum, L1 about twice length of L1; SV1 and SV2 on a common pinaculum, SV1 about twice length of SV2; MV3 extremely close together; V1 arranged in venter. Meso- and metathoraces: D1 dorsal to D2, D2 about twice as long as D1; SD2 dorsal to SD1, SD1 about twice length of SD2; L1 and L3 on a common pinaculum; L2 ventral to L1 and L3; SV1 as long as L1; MV2 and MV3 extremely close together; V1 arranged in venter. First and second abdominal segments: D2 posterodorsal to D1, D2 about twice length of D1; SD1 dorsal to spiracle; SD2 nearer to spiracle than SD1; L1 posterodorsal to L2; D1, SD1, L1, L3, SV2, SV1 and V1 arranged almost in vertical line. Third to eighth abdominal segments similar to two anterior segments except for the following points; SV1 and SV2 on a common pinaculum, SV3 dorsal to SV2. Seventh to ninth abdominal segments: D2, D1, SD1, L1, L3, SV1 and V1 arranged almost in a vertical line; D2 dorsal to D1; SD1 twice length of SV1; SVI on a pinaculum, SV2 absent. Tenth abdominal segment bearing 5 pairs of setae on anal shield and 6 pairs of setae on ventral plate.

Mature larvae examined: [Kyushu] (Fukuoka Pref.) 4exs, No-touge, Miyako-machi, 23. viii. 2014, Y. Osada leg.

Pupa (Figs 6-7). Length about 10 mm. Body slender, head dark brown and thorax and abdomen pale brown; dorsal surface of thorax rather flat. Clypeolabral area more or less elongate with two pairs of setae, galea as long as labial palpus, tapered distally; antenna long,elongate posteriorly, shorter than length of forewing. Forelegs with tips ending before middle of forewing and separated from each other; midleg not extending beyond tip of forewing; hindleg extending beyond tip of forewing. Posterior margin of metanotum slightly arched posteriorly. Mesonotum and metanotum each with two pairs of setae (Figs 6C, 7A). Third to ninth abdominal segments transversely with two series of dorsal spines

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(Figs 6A, C, 7B). Second to eighth abdominal spiracles projecting. Fifth to sixth abdominal segments with a pair of proleg scars. Seventh to tenth abdominal segments with two pairs of small dorsal and lateral projections (Figs 7C-D).

Pupae examined: [Kyushu] (Fukuoka Pref.) 2♂2♀, Notouge, Miyako-machi, 21. viii. 2013, Y. Osada leg.

Distribution. Japan: Honshu, Shikoku (newly recorded) and Kyushu. China: Fujian, Guangdong, Jiangxi and Zhejiang.

Host fungus. *Cryptoporus volvatus* (Peck) Shear.

Biological notes (Fig. 8). Mature larvae were collected from *Cryptoporus volvatus* on August 20, 2013, at Notouge, Miyako-machi, Fukuoka Pref. The larvae bore into the fruit body and feed on it. The larva made a cocoon within or in an interstice of the fungus and pupated in the cocoon. The pupae extruded the anterior half of its body above the surface of the fruit body and the adult then emerged.

Discussion

The present study describes the morphological characters of the adult, the genitalia and the immature stages of *A. japonica*. Previous studies have shown that two L-group setae are present on the prothoracic segment in the genera *Scardia*, *Morophaga* and *Morophagoides* (Zagulajev, 1973; Moriuti, 1976; Sakai, 2011). As for the immature stages, Robinson (2009) noted "larva with only two prothoracic L-group setae" as one of the characters of the Scardiinae. In the present study, we confirm this morphological feature in *Amorophaga japonica*. By contrast, the V1 seta of the prothorax is present in *A. japonica* as well as in species of the genus *Morophaga*, but the V1 is absent in *Morophagoides ussuriensis* (=*moriutii*) (Moriuti, 1976). The presence or absence of prothoracic V1 may be an important character in the Scardiinae. In order to clarify phylogenetic relationships and the various generic characters within the subfamily Scardiinae, further detailed examination of immature and genital morphology and molecular analysis are required.

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摘　要

スジモンオオヒロズコガ（鱗翅目，ヒロズコガ科）の成虫と幼生期の形態（長田庸平・坂井　誠・広渡俊哉）

スジモンオオヒロズコガ*Amorophaga japonica* Robinson, 1986は日本（本州，九州）や中国（福建省，広東省，江西省，浙江省）に分布し，幼虫の寄主はサルノコシカケ科のヒトクチタケが知られる．Robinson (1986)によって雄交尾器が，Yang and Li (2013)によって雌交尾器が図示されたが，幼生期の記載

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は行われていなかった．そこで，筆者らは本種の雌雄交尾器や翅脈を図示し，初めて幼虫・蛹形態の記載を行った．なお，本種を初めて四国から記録した．

本種の幼虫はヒトクチタケの子実体の内部を穿孔し，その子実体の内部や隙間に繭を形成し，その中で蛹化する．そして，子実体の外側に蛹の前方部を突き出して羽化する．

本属を含むオオヒロズコガ亜科の幼虫は，前胸のL刺毛群が2本である特徴を有する．また，本種は同亜科の*Scardia*属や*Morophaga*属と同様に前胸にV1を有すが，*Morophagoides*属はこれを欠く．前胸のV1の有無はオオヒロズコガ亜科内で重要な形質である可能性があるが，今後さらに調査する必要がある．

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